

14

Self study as a mechanism to foster hopeful teaching

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Teaching mathematics education to pre-service teachers (PSTs) enrolled at university is problematic, due to their lack of agreement about the extent to which they are prepared for teaching school mathematics. Pre-service preparation in South Africa currently occurs in the university, which impacts on the teaching of mathematics education. Noting such a context for teacher education, with its attendant dilemmas, this chapter attempts to present and explore a theoretical basis for helping us to understand what it means to teach mathematics education in such a context. I argue that such a theoretical basis is useful, providing perspectives on the practices of mathematics educators in the light of calls for teaching for the public good. The chapter takes the form of an analysis of selected excerpts of PSTs' views of my teaching of mathematics education in a four-year Bachelor of Education (B.Ed) programme. There are a growing number of university-based science and mathematics educators who study their teaching; ie they engage in self-study. The question considered is: what might teaching for the public good of mathematics education in pre-service preparation at a university be like?

The idea to gather the empirical data presented in this chapter arose in the meetings of a group of interfaculty members of the Critical Professionalism group at Stellenbosch University, who expressed an interest in studying their own teaching by considering their students' experiences of the modules they taught (see Leibowitz and Holgate, chapter thirteen). For my part of the collective effort, I decided to adapt and use some of the questions concerned to conduct a self-study on the basis of the mathematics education modules I taught.

Theoretical orientation

Different but connected strands of literature are referenced, to address the following areas: the role of the university in relation to self-study in the case of mathematics teacher educators; the functions of a university and university teaching; the central tasks that must be performed during pre-service preparation in teacher education; mathematics education; and concepts pertaining to the public good. In reviewing key concepts in each strand of literature I construct an analytical framework to make sense of empirical excerpts from PSTs' experiences of my teaching that aimed to illuminate teaching for the public good.

A self-study (Loughran, 2007; 2002) of my teaching as a university-based mathematics educator is important, since it enhances my understanding of what I do and allows me to communicate the functions of the university in my academic preparation of mathematics teachers. Engaging in such self-study resonates with Shulman's (1999) notion of the scholarship of teaching, which depends on three key attributes: becoming public; becoming an object of critical review and evaluation by members of the mathematics and teacher education communities; and starting to use and build on the insights by members of the communities concerned.

As Habermas expounded, teaching at a university is intimately connected to the functions of a university and I refer to his work and that of other scholars who write on the role of the university. Habermas (1989:121) posits one of the functions of the university as 'the academic preparation of public service professionals – professional and vocational knowledge'. His view is particularly appropriate in the case of pre-service preparation involving PSTs who are enrolled for certificate studies for teaching mathematics in school. During their university education, PSTs should be encouraged to adopt a hypothetical attitude vis-à-vis facts and norms (Habermas, 1987:19), especially with regards to the teaching and learning of such a cultural tradition as school mathematics. Habermas further argues that all education produces and reproduces the 'lifeworld' and thus serves to mediate the individual and the society in which they live.

McLean (2006) suggests that Habermas sees the lifeworld as a broad complex world made up of the practices, customs and ideas of individuals or groups. The last concept applies to PSTs enrolled at a university and their ideas about what they need to do and know when teaching school mathematics. Habermas places the university between the social and cultural structures of the lifeworld (McLean, 2006). The school forms part of a social and cultural

SELF STUDY AS A MECHANISM TO FOSTER HOPEFUL TEACHING

structure and aims, amongst other goals, to produce and reproduce society and culture. In a more encompassing sense, Habermas conceives of the university as a lifeworld, a 'complex bundling of functions' in a single society rather than a group of unrelated functional social systems including the professional preparation of PSTs (Ostovich, 1995:476).

Teaching for the public good can be interpreted as an educational slogan (Scheffler, 1960/1964) or a rallying cry that aims to develop and strengthen the connections between the various functions of the university with respect to the school, society and culture – of which a particular function is pre-service preparation. Teaching for the public good has to contend with the reality that the university and the school are two quite different institutions with different goals (Labaree, 2006; 2008). Figure 14.1 attempts to capture the position of teaching for the public good at the university in relation to its position in society and in school.

The porous lines in Figure 14.1 indicate the interdependence of school, university and society, with the activities in each sphere influencing those in the others. The choice of a Doppler diagram is intended to show the inter-relationships between the university, school and society. The bottom end of the diagram draws particular attention to instances where the three components – university, school and society – interact. Figure 14.1 captures Habermas' view of the university as a lifeworld, comprising a complex bundling of functions oriented towards action regarding which school and society-related values are continuously under discussion (Ostovich, 1995:467).

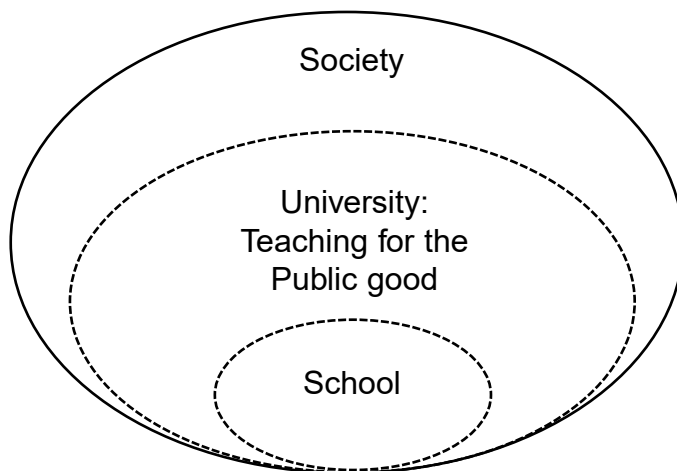


Figure 14.1: The positioning of teaching for the public good at the university, with respect to society and school

HIGHER EDUCATION FOR THE PUBLIC GOOD: VIEWS FROM THE SOUTH

In the case of PSTs enrolled at a university, teaching for the public good involves the teaching of what Feiman-Nemser (2001) calls the ‘central tasks’ in pre-service preparation. These tasks exemplify one of the functions of the university: the academic preparation of public service professionals (McLean, 2006:16). The tasks, McLean argues, must include the teaching of what PSTs need to know, what they care about and what they are able to do in order to promote substantial learning for all school learners. The central overlapping tasks consist of analysing their beliefs, forming new visions, developing subject matter knowledge for teaching, understanding learners and learning and building a beginning repertoire and tools for studying teaching. Although the tasks generally concern teacher preparation, they can each be connected to existing literature on mathematics education. In practical terms, such tasks cannot be addressed solely in mathematics education modules at a university, but should also be taught in the other university-based modules that make up the PSTs’ degree programme.

To relate the notion of central tasks to mathematics education, a working definition of mathematics education and its teaching is required. Mathematics education is a complex domain of knowledge concerned with articulating relationships between two knowledge objects: mathematics and teaching. Adler and Davis (2006) appropriately describe the tension that exists between the two different knowledge objects, acknowledging that mathematics has a ‘strong grammar’ in the form of symbols and abstraction whereas teaching has a ‘weak grammar’. They note that the latter depends on learning theories and learners’ psychological states. Unsurprisingly, recent developments in mathematics education refer to a ‘mathematics for teaching’, which relates to a central task in pre-service preparation: the development of subject matter knowledge for teaching. So when teaching mathematics education to PSTs the complex nature of both mathematics and teaching have to be kept in mind.

For reasons related to building a beginning repertoire and the development of subject matter knowledge for teaching, it is noteworthy that the mathematics (content) offered in pre-service preparation is a ‘mathematics-education-researcher’s (MER)’ (Sfard, 1998). As a variety of mathematics (Julie, 2002), MER mathematics deals mostly with versions of mathematics that are elementary, such as the connections between, and the development of, mathematical ideas. It is structured by the insights gained from learning theories, pedagogy and the history and philosophy of mathematics. The language and terminology associated with MER mathematics include, amongst others, references to facilitating strategies, the decompressing of mathematical symbols and privileging process over product or answers.

SELF STUDY AS A MECHANISM TO FOSTER HOPEFUL TEACHING

MER mathematics differs in discursive ways from what Julie calls 'school-teaching mathematics', which is subject to the organisation of the school in terms of content. School-teaching mathematics is highly fragmented and focuses more on the provision of single answers than on gaining structural insights into abstractions (Watson, 2008). Through our own schooling, we have encountered school-teaching mathematics in the form of an 'apprenticeship of observation' (Lortie, 1975:61) – namely, the time we have spent in school. The same argument, which holds in the case of PSTs, is influenced by various actors, including the education bureaucrats, teachers, principals, parents, test-makers, textbook writers and school board members.

On data and method

At the time of collecting their written responses to my teaching of mathematics education, the PSTs had been my students for two consecutive mathematics education modules: Math Ed 278 and Math Ed 378. The modules are taken during the second and third years of the four-year Bachelor of Education (B.Ed) programme, which upon completion certifies the PSTs to teach mathematics to the middle grades (grades 4 to 9) in schools. Each module runs for one academic year. In Math Ed 278 the content focuses on fractions from an advanced standpoint: one informed by a knowledge of the relevant mathematics education literature. For example, the PSTs are taught the many interpretations of fractions, such as those relating to part-whole fractions, ratios, decimals, percentages, and rates. In accordance with the advanced standpoint, the interpretations are investigated numerically, algebraically and geometrically where possible. In Math Ed 378, the content focuses on algebraic thinking and probabilistic reasoning.

During Math Ed 278 and Math Ed 378 the PSTs are provided with opportunities to form new visions, develop their beginning repertoire and consider what it takes to transform school mathematics for the purposes of teaching and learning. The content and teaching of these two modules are therefore informed by the central tasks of pre-service preparation. The modules bring PSTs into contact with mathematics education and, specifically, with MER mathematics, which is discursively different from school-teaching mathematics. The PSTs' written responses to the Critical Professionalism group questionnaire discussed in chapter thirteen were collected towards the end of the Math Ed 378 module, in the third year of the B.Ed programme. The timing of the data collection was appropriate, since the data would help gauge the PSTs' experience of the current sequence of mathematics education modules. The PSTs' written responses to the questionnaire took the form of self-re-

HIGHER EDUCATION FOR THE PUBLIC GOOD: VIEWS FROM THE SOUTH

ports. As a data corpus, the written responses formed part of a larger data set generated by the Critical Professionalism group members, who teach in other faculties of Stellenbosch University. Although 26 PSTs were requested to complete the questionnaire, not all responded.

Methodological issues concerning the data analysis require clarification and justification. As a primary issue, evidence of teaching for the public good is contained in the PSTs' written responses that related to their preparation for teaching school mathematics. The qualitative method of comparison (Corbin and Strauss, 2008) was used to analyse the data excerpts which exemplified teaching for the public good. Comparisons were drawn between some of the central tasks that are taught during pre-service preparation in mathematics education and the PSTs' reflections on these tasks. Drawing such comparisons is a way of answering the following research question: what might teaching for the public good of mathematics education in pre-service preparation at a university be like? The implications of such a question are also covered.

A second methodological issue relating to the study described here is the self-study of my teaching. As the PSTs reported on my teaching, they may have been biased since I analysed the data excerpts. As a researcher/mathematics educator, I 'worked on the inside' (Ball, 2000), using my own teaching of mathematics education as a site for studying teaching and learning and for understanding the functions of the university. Such a research genre requires 'distance' (Adler *et al*, 2005) – the adoption of a critical perspective when reporting and analysing findings. According to Bhabha in his work on post-colonial theory (1984), in which he describes his use of mimicry, the 'other' (or the colonised) copies, or aspires to be like, the coloniser. To deal with the distance concerned, this concept of mimicry is appropriate to assess instances where the PSTs are in agreement with my teaching and where, for example, they begin to appropriate MER mathematics discourse. Hence, it is necessary to report the PSTs' respective agreement and disagreement with regards to my teaching. For reasons of space, the analysis of only three excerpts from the PSTs' reports – which range from disagreement to agreement – are presented. Each PST referred to was assigned a pseudonym.

Teaching for the public good: mathematics education in pre-service preparation

The first PST, Anne, questioned the degree to which she had been prepared to teach school mathematics, especially in terms of content and teaching. Writing about her experiences in the mathematics education modules, she states the following:

SELF STUDY AS A MECHANISM TO FOSTER HOPEFUL TEACHING

Anne This course, with reference specifically to mathematics, has been an 'Ok' module of the course. To be truly honest, I do not want to teach maths in schools as I do not feel properly trained/educated. This module has not brought desire into my heart to teach maths. Merely trying to understand what is actually being asked is a challenge, and I am a very strong maths student. I would like this course/module to be revised. I would like to suggest that our course, and specifically major subjects such as mathematics, be content-based. Too many teachers are lacking content. Now in our third year, we know how to teach and now we need proper content – content that is addressed in schools.

Although Anne starts by acknowledging that the mathematics component of the course has been 'Ok', she quickly expresses her disagreement through the use of such phrases as 'to be truly honest' and 'has not brought desire into my heart to teach maths'. She provides specifics in comparing the content of the mathematics education modules with that of school mathematics. According to her, the content in the modules is not the 'proper content – content that is addressed in schools'. One particular reason she provides is that teachers in schools are 'lacking content'. She also states that she found the content of the modules difficult to understand: 'merely trying to understand what is actually being asked is a challenge, and I am a very strong maths student.' It is noteworthy that she regards mathematics and teaching as two separate knowledge objects. For instance, she writes: 'now in our third year, we know how to teach and now we need proper content – content that is addressed in schools'.

In terms of her preparation, the second PST, Tami, noticed a difference between the content of the mathematics education modules and school mathematics ('the curriculum'), as can be seen in the following excerpt from her observations:

Tami I found this course extremely challenging at first. Now I find it easier. What excites me is the way we approach maths and all the connections we are making, for example the different interpretations of fractions. What I find difficult and frightening is I don't know how I am going to apply everything to the curriculum. I am also concerned about those other aspects of the maths curriculum that we are not going to cover, because I don't know if I will be able to apply the same approach and methods by myself.

Evidence of the difference in content is shown in Tami's description of what 'excites' her, such as 'the different interpretations of fractions'. According to Tami, the mathematics content in the modules focuses on 'connections', which refer to the many interpretations of fractions, such as part-whole

HIGHER EDUCATION FOR THE PUBLIC GOOD: VIEWS FROM THE SOUTH

fractions, ratios, decimals, percentages, and rates, for example. She is concerned that she will not be able to 'approach' school mathematics ('the curriculum') by applying the 'same approach and methods' on her own. Implicitly, she has made a comparison between the mathematics in the modules and school mathematics ('the maths curriculum').

The third student, Liezel, describes her preparation for teaching school mathematics in ways that are specific to the mathematics education discourse. For example, she articulates the relationships between mathematics and teaching, as can be seen in the following excerpt:

Liezel The course has enabled me to acquire a new perspective on mathematics and teaching approaches. We often underestimate learners and go with the assumption that we have to tell them what to do all the time. This programme has actually proved the opposite. In mathematics especially, children can be led by means of the correct facilitating strategies and probing questions, to use their own methods by means of inherent experimental processes to formulate and thereby solve the problems posed to them. The modules have changed my approach to mathematics. By and large, we are taught to follow a product-oriented mathematical approach. In this programme, however, there is emphasis on the opposite (process-oriented) approach as a way to highlight the necessity of the child's mathematical development. (Liezel, translated from the Afrikaans)

Liezel refers to some of the central tasks of pre-service preparation, including forming a new vision – what she calls 'a new perspective on mathematics and teaching approaches'. By claiming to regard mathematics with an eye on teaching and the needs of learners, she expresses concern with learners and learning. The excerpt illustrates her awareness that many children find learning mathematics difficult. Accordingly, she writes about decompressing mathematics by using 'facilitating strategies' and 'inherent experimental processes' that are concerned with the 'child's mathematical development', the goal of which is to provide structural insights into mathematics. Liezel cautions against underestimating learners and advocates the use of particular teaching strategies. Examples include her references to 'facilitating strategies' and 'probing questions' where 'they use their own methods'. She points out 'inherent experimental processes to formulate and thereby solve the problems posed'. Her analysis of the prevailing situation reveals the kind of mathematics problems she has in mind: those in which mathematics, with its strong grammar, can emerge via the adoption of a process-oriented approach. Liezel seems to be aware of the importance of mathematics for teach-

SELF STUDY AS A MECHANISM TO FOSTER HOPEFUL TEACHING

ing, with her epistemic formulations of mathematics akin to those of MER mathematics.

Discussion and conclusion

A comparison of the observations of Anne, Tami and Liezel reveals how their responses about being prepared to teach school mathematics differ. Anne, unlike Liezel, does not see the need to subject the strong grammar of mathematics to specific views of teaching. In terms of her preparation, Anne wants teaching and mathematics to be kept as two distinct knowledge objects. She wants the mathematics content in the mathematics education modules to be like the 'proper content' addressed in school. She does not see the need to consider mathematics for the purposes of teaching, unlike MER mathematics. Tami is excited about the various mathematical 'connections' that have been highlighted through the use of teaching 'approach and methods' in the mathematics education modules. Liezel, by contrast, seems inclined to adopt a hypothetical attitude vis-à-vis the facts and norms that are usually associated with a cultural tradition, such as those that form part of mathematics with its strong grammar. She articulates where a type of mathematics – MER mathematics – emerges through particular teaching processes that make the content in school mathematics gradually more sophisticated.

We might regard what Liezel describes as a mimicking of mathematics education with its associated discourse, which she quite likely picked up from my teaching; she might have simply worked out what the ideal PST should say. This does not imply that she is unaware of the implications of what she is saying, however. On the contrary, by mimicking MER mathematics discourse she shows she is making a transition, albeit only verbally, from her earlier mathematics experiences. Evidently, she is influenced by MER mathematics and its related discourse in ways that resemble the coloniser's exercise of power over the colonised, resulting in mimicry on the part of the latter. In terms of such an understanding, the power and status that the university has in relation to the school is given due consideration.

In contrast, Tami seems to be aware that there are other connections within and between the different branches of school mathematics content that have not been expounded in the modules and which she does not know how to comprehend on her own. It is not possible to prepare PSTs like Tami to teach the entire school mathematics content because the university and the school have different but overlapping goals. One goal within the modules is for Tami to acquire conceptual tools to understand and identify the different branches of the content of school mathematics. A narrow interpretation of preparation

HIGHER EDUCATION FOR THE PUBLIC GOOD: VIEWS FROM THE SOUTH

for PSTs like Tami would amount to a 'front load' (Doyle and Carter, 2003) of all the school mathematics content in the modules. The latter is simply not possible because the two institutions have different time constraints.

Anne's remarks about the 'proper content' deserve attention because, by way of negative implication, they point to the issue of the public good in the teaching of mathematics education. The mathematics content, as it is taught at school, is subject to a particular timetable which differs from that of the university. Thus her suggestion that the proper mathematics content of the middle grades be covered after the third year – namely, during the final year of the B.Ed programme in the university – simply does not make sense. More importantly, the 'proper' school mathematics content is subject to test-makers, various teachers' input, the principal's knowledge and awareness, textbook publishers, education department bureaucrats and school board members. In terms of content, however, the teaching of mathematics education in pre-service preparation is characterised by the presence of more transformative goals related to the public good. Examples are the central tasks such as the development of the analysis of belief systems and the formation of new visions, of subject matter knowledge for teaching, of understandings of learners and learning, of a beginning repertoire, and of tools for the study of teaching. In contrast, Tami and Liezel appear to have some understanding of what the university is communicating in terms of pre-service preparation.

At another level, the excerpts from the three PSTs have implications for university practice. Taken as reflections of teaching for the public good, they are an overt admission that much is awry with the function of a university in relation to school and society. The excerpts should therefore not be taken as literal expressions of PST understanding *per se*, but more as revealing the relationships that exist between the university and the school. For example, the teaching of mathematics education for the public good represents a particular intersection between the lifeworlds of PSTs and the lifeworld of the university. The university values, and is concerned with, the academic knowledge that is clearly identified in Liezel's words. For her words to be understood in the context of the school requires 'boundary crossing', if we are to take the educational slogan of teaching for the public good seriously. Also, Anne's response, which is indicative of that which is expressed by society as a whole, implies that different varieties of mathematics are not widely known, heard or seen, as is necessary in the preparation of school mathematics teachers.

In conclusion, teaching for the public good is a concept the university employs to draw attention to its distinctive lifeworld. The specified lifeworld

SELF STUDY AS A MECHANISM TO FOSTER HOPEFUL TEACHING

is related to one of its bundled functions: the academic preparation of those public service professionals who are mathematics teachers. In particular, evidence for teaching for the public good is contained in the PSTs' thinking about my teaching of mathematics education. On entering a university, PSTs come into contact with a lifeworld with which they come, in a variety of ways, to disagree or agree regarding the extent to which they are being prepared to teach school mathematics. In theoretical terms, it has been argued that such a lifeworld has to do with the teaching of the central tasks that are vital and specific to mathematics education in pre-service preparation. In practical terms, examples of teaching for the public good in mathematics education in pre-service preparation have been shown from the perspectives of three PSTs.

In theoretical terms, the excerpts of the PSTs, although given as self-reports, reveal their own lifeworlds coming into contact with the lifeworld of the university, in the form of the practices associated with mathematics education as a discipline (Freudenthal, 1973). The lifeworld of the latter implies that the PSTs must come into contact with a variety of mathematics that differs from the school-teaching mathematics they experienced in their own schooling. Also implied is the fact that they must come into contact with those epistemological and pedagogical issues that are related to the form of school mathematics – exemplified in mathematics education discourse in the case of Liezel. Thus, teaching mathematics education to PSTs at a university constitutes a necessary break in their journeys from school to university and back into the school environment upon the completion of their degrees. Such contact with the university is a first encounter for most PSTs, constituting a time out that provides an incomplete preparation for their entry into the world of teaching. As Dewey (1938) warned: preparation is a 'treacherous' idea when used in regard to education.

The PSTs' experiences reported on in this chapter should prepare them for their later experiences in the school environment, which are bound to be deeper and more expansive than at university (Feiman-Nemser, 2001:1016). In the South African schooling context these experiences are intertwined with particular and peculiar realities tied to the country's apartheid past. Such broadening of experience has implications for the (lack of) connections that exist between the university and the school and how the former communicates its lifeworld through its teachers and their teaching.

My ongoing professional development in teaching mathematics education has been affected by my reading of Habermas' ideas on the role of the university. I therefore envision a more fundamental role for Stellenbosch University

HIGHER EDUCATION FOR THE PUBLIC GOOD: VIEWS FROM THE SOUTH

in terms of reversing effects on schools and the society that it helped shaped in the past.

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